(12) UK Patent Application (19) GB (11) 2 084 885 A

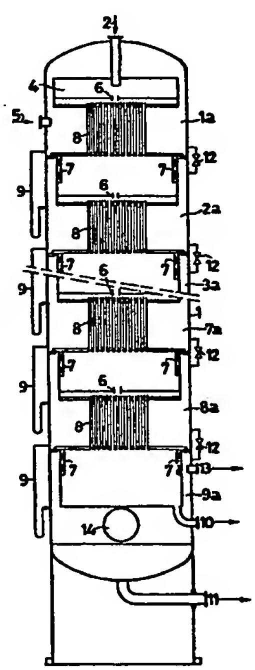
(21) Application No 8124674
(22) Date of filing
12 Aug 1981
(30) Priority data
(31) 24359
(32) 29 Aug 1980
(33) Italy (IT)
(43) Application published
21 Apr 1982
(51) INT CL³ B01D 1/06
1/22 3/32
(52) Domestic classification
B1B 207 306 403 603
711 GC KA2
(56) Documents cited
GB 1537468
GB 1495737
GB 1411676
GB 1282030
GB 614312
GB 520242
(58) Field of search
B1B

(71) Applicant
Snamprogetti SpA
Corso Venezia 16
Milan
Italy
(72) Inventors
Vincenzo Lagana
Virginio Cavallanti
(74) Agents
Haseltine Lake & Co
Hazlitt House
28 Southampton
Buildings
Chancery Lane
London WC2A 1AT
England

(54) **Process for the concentration of aqueous glycol solutions**

(57) The process relates to the concentration of an aqueous glycol solution by evaporation of the solution, in the form of a thin film, in a set of multiple-effect vertical film evaporators (8) arranged one above another in a column.

Fig.2

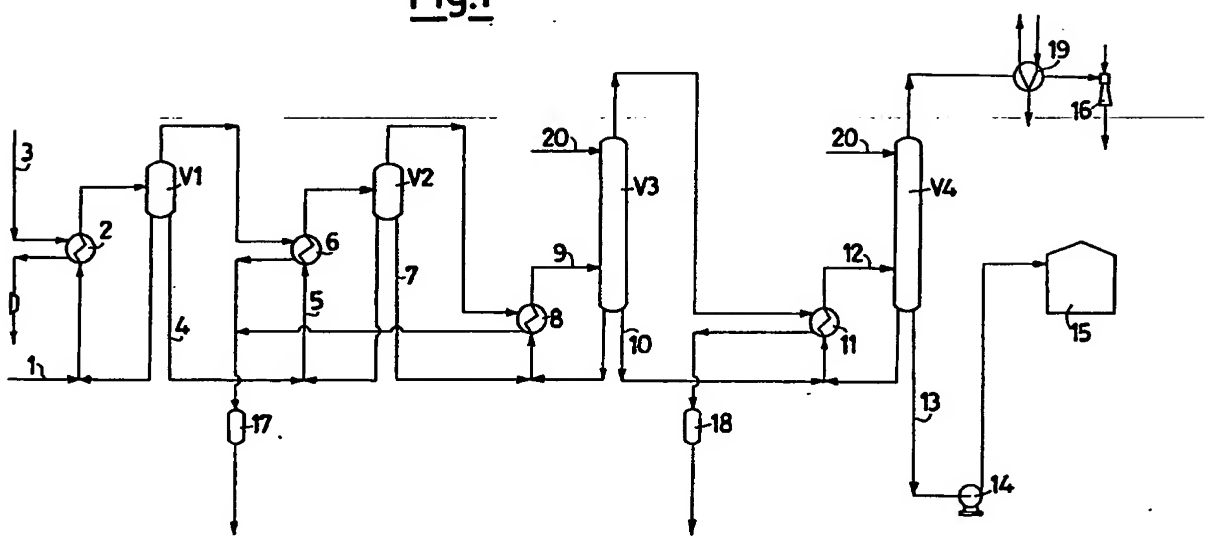


The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 084 885 A

2084885

Fig.1



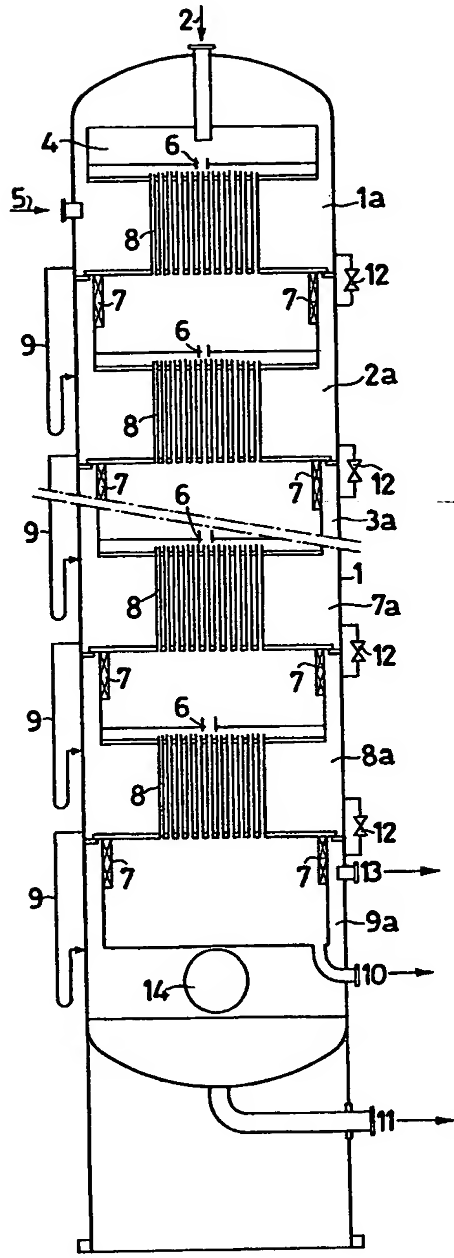


Fig.2

SPECIFICATION

Process for the concentration of aqueous glycol solutions

The present invention relates to a process for concentrating aqueous glycol solutions.

At the present time the concentration of aqueous solutions of glycols is carried out in an installation having sequentially arranged reboilers and evaporators, as schematically shown in Fig. 1 of the accompanying drawings. In this installation the aqueous glycol solution having a low content of glycol is fed through line 1 and an exchanger 2 (where it is heated at the expense of stream fed through a line 3) to a first evaporator V_1. From the lower part of the first evaporator V_1, through a line 4, a more concentrated solution is obtained. This solution, through a line 5 and an exchanger 6, is sent to a second evaporator V_2, from which the solution obtained, through a line 7, an exchanger 8 and a line 9, is sent to a third evaporator V_3. From this latter, through a line 10, an exchanger 11 and a line 12, a still more concentrated solution is sent to a final evaporator V_4, kept under vacuum (about 150 mm Hg) by means of an ejector 16. In the evaporator V_4, the solution becomes further concentrated and, through a line 13 and a pump 14, is sent to a tank 15. From the head of the first three evaporators, steam mixed with small amounts of glycol is obtained. This steam is condensed in the exchangers 6, 8 and 11, and is collected in vessels 17 and 18. The vapours that leave the head of the fourth evaporator V_4 are condensed in a cooler 19 and, together with the other glycol-laden condensates, are recycled to the installation. In order to avoid excessive loss of glycol in the vapours, washing water is passed through lines 20 into the head of each evaporator V_3 and V_4.

According to the present invention, there is provided a process for concentrating an aqueous glycol solution, which comprises causing the solution, in the form of a liquid film, to undergo evaporation in one or more vertical film evaporators, using the principle of multiple-effect distillation.

Preferably, the process of the invention is carried out in a vertical column comprising (a) a plurality of first chambers and a plurality of second chambers, which first and second chambers are disposed one above the other in the column, the first chambers being connected together by tube bundles each of which bundles extends vertically, through a respective one of said second chambers, from one of said first chambers to the next, whereby in use the solution can undergo evaporation whilst flowing down said first chambers and said tube bundles; (b) means connecting each of said first chambers (apart possibly from the uppermost one thereof) to the respective second chamber beneath it whereby in use vapor produced in said first chamber can flow into said second chamber for condensation therein; and (c) means connecting each of said second chambers (apart from the lowermost one thereof) to the next lower second chamber whereby in use condensate produced in said second chamber can flow into said next lower second chamber.

More preferably, the process is carried out in a single vertical column divided into a number of cylindrical stages, each of which comprises (a) one or more film evaporators comprising vertical tube bundles without any external shell; (b) one or more trays, each of which is connected, at the bottom thereof, to the upper tube bundle of one of the film evaporators that are in the same stage, the tray being connected in the last stage without any film evaporator to a pipe that leads to a tank for the concentrated solution of glycol, whereas, at its upper part, it is connected to the lower tube plate of one of the film evaporators that are in the upper stage, the trays being connected in the first stage directly to a pipe for feeding the glycol solution to be concentrated; (c) a system for sealing and for adjusting the rate of flow, placed on the bottom of every tray, having the purpose of adjusting the passage of the glycol solution from the tray to the underlying film exchanger; (d) openings provided at the tops of the lateral portions of every tray, the trays of the first section excepted; and (e) one or more siphon tubes connecting two adjoining stages and having the purpose of transferring the condensate collected in every stage to the next stage; the first stage being also provided with a pipe for feeding the solution to be concentrated to the trays and for introducing saturated steam intended for heating the solution, the last stage being provided with a pipe for discharging the condensate, for extracting the concentrated glycol solution and for connection to a vacuum system.

For a better understanding of the invention, reference will now be made, by way of example, to Fig. 2 of the drawings which shows an example of an installation in which the process of the invention can be carried out.

In the installation of Fig. 2, the overall number of stages is assumed, merely by way of illustration, to be nine and a single small tray and a single film evaporator are assumed to be provided in each stage.

In the drawing of column 1, there are indicated the first three stages 1a, 2a and 3a and the last three stages 7a, 8a and 9a of the column. The three intermediate stages are not shown for the sake of space. The nine stages 1a to 9a together form a first series of chambers.

The solution to be concentrated, which is obtained from an ethylene oxide plant and which is

quite warm (as the reaction of ethylene oxide with water to form glycols is exothermic), is sent to a small tray 4 of the first stage 1a, through a pipe 2. From the small tray 4, the solution is passed, through a system 6 for sealing and for the adjustment of the flow rate, into film evaporators 8 where it is additionally heated by live steam entering through pipe 5. It is then passed into the small trays and into the underlying evaporators 8, thus becoming more and more concentrated up to the last stage 9a, where it attains the maximum concentration and from which it is passed through a pipe 10 into a storage tank. The nine trays 4 together form a second series of chambers.

The vapours that are evolved in the small trays below the first stage 1a expand through outlet ports 7 and are condensed externally of the tubes of the film evaporators 8 while concurrently heating the solution flowing inside the tubes.

The condensates which collect at the bottom of every stage are passed from one stage to the next by siphoning tubes or pipes 9, down to the last stage, wherefrom they are discharged via a pipe 11. The vapours passing through the ports 7 of the last stage 9a are condensed by a jacketed condenser 14.

Valves 12 and associated tubes serve to transfer the inert gases possibly present from one stage to the next. The last stage 9a is connected via a pipe 13 to a vacuum system.

In order to show the advantages achieved by the use of the installation of Fig. 2 for concentrating aqueous solutions of glycols as compared to the conventional process, the concentration of a solution of glycols was carried out, by way of example, by feeding two installations one being as shown in Fig. 1 and the other being as shown in Fig. 2, with the same amount per hour of an aqueous solution of glycols (namely a 12% solution), at the same temperature and under the same pressure. The results are given in the following Table.

Table

Installation of Figure 1	Parameter	Installation of Figure 2
41370 kg/hr	Amount of 12.7% solution	41370 kg/hr
150°C	Temperature	150°C
13 kg/cm^2	Pressure	13 kg/cm^2
5952 kg/hr	Amount of concentrated solution obtained	5900 kg/hr
84.85% by weight	Concentration	88% by weight
84°C	Outlet temperature	73°C
0.2 kg/cm^2	Outlet pressure	0.1 kg/cm^2
9150 kg/hr at 17 kg/cm^2	Steam consumption	1690 kg/hr at 3.7 kg/cm^2

The concentration of the incoming solution was 12.7% by weight and that of the solution obtained was 88% by weight. If the concentrations at the inlet or at the outlet are varied, the pressures and temperatures at the inlet and the outlet of the column will also be varied. Normally for a range of glycol concentration of from 0 to 100%, the concentration is carried out in a pressure range of from 20 to 0.03 kg/cm^2 and in a temperature range of from 200 to 30°C.

Summing up, the use of an apparatus as described with reference to Fig. 2 enables the following advantages to be achieved:

(a) A considerable saving of steam for heating is achieved. The consumption of steam to concentrate 41370 kg/hr of solution by the installation of Fig. 1 is 9150 kg/hr whereas the consumption to process the same amount of solution by the installation of Fig. 2 is about 1690 kg/hr. The saving of steam is therefore

$$\frac{9150-1690}{9150} \times 100 = 81.5\%.$$

(b) Lower costs of production of saturated steam for heating is achieved, since for the installation of Fig. 2, a steam pressure of 3.7 kg/cm^2 suffices, while, for the installation of Fig. 1, steam at 17 kg/cm^2 is necessary. The pressure of the saturated steam for heating ranges between 2 and 4 kg/cm^2 depending upon the initial concentration and the final concentration of the solution.

(c) Greater simplicity and reliability of the system as a whole is achieved. In fact, in the case of the installation of Fig. 2, a single column replaces the assembly of several columns of the

installation of Fig. 1.

(d) The lower running cost of the installation of Fig. 2 enables the initial cost of the installation to be recouped within about two years. Thus, the cost of an installation as shown in Fig. 2 for processing 41370 kg/hr of solution has been estimated to be about 1050 million lire. Assuming the operation hours to be 8000 yearly, the cost of saturated steam at 3.7 kg/cm^2 to be 7 lire/kg and the cost of saturated steam at 17 kg/cm^2 to be 10 lire/kg, the yearly saving would be $(10 \times 9150-70 \times 1690) \times 8000 = 637.4$ million lire per year, which would enable the invested capital of 1050 million lire to be recouped within two years.

CLAIMS

1. A process for concentrating an aqueous glycol solution, which comprises causing the solution, in the form of a liquid film, to undergo evaporation in one or more vertical film evaporators, using the principle of multiple-effect distillation.

2. A process according to claim 1, the process being carried out in a vertical column comprising (a) a plurality of first chambers and a plurality of second chambers, which first and second chambers are disposed one above the other in the column, the first chambers being connected together by tube bundles each of which bundles extends vertically, through a respective one of said second chambers, from one of said first chambers to the next, whereby in use the solution can undergo evaporation whilst flowing down said first chambers and said tube bundles; (b) means connecting each of said first chambers (apart possibly from the uppermost one thereof) to the respective second chamber beneath it whereby in use vapour produced in said first chamber can flow into said second chamber for condensation therein; and (c) means connecting each of said second chambers (apart from the lowermost one thereof) to the next lower second chamber whereby in use condensate produced in said second chamber can flow into said next lower second chamber.

3. A process according to claim 2, wherein steam is fed to the uppermost second chamber, for heating the solution flowing in the tube bundle extending through said uppermost second chamber.

4. A process according to claim 3, wherein the pressure of the steam is from 2 to 4 kg/cm^2.

5. A process according to any of claims 2 to 4, wherein each first chamber is disposed at least partly within a respective one of said second chambers, and wherein the means connecting said first chamber to said respective second chamber is a port allowing communication between said first and second chambers.

6. A process according to any of claims 2 to 5, wherein the means connecting each second chamber to the next lower second chamber is a syphon tube.

7. A process according to any of claims 2 to 6, wherein each first chamber includes means for controlling the rate of flow of solution therethrough.

8. A process according to any of claims 1 to 7, wherein the evaporation, or each stage thereof, is effected at a pressure of from 0.03 to 20 kg/cm^2 and at a temperature of from 30 to 200°C.

9. A process according to claim 1, substantially as hereinbefore described with reference to Fig. 2 of the drawings.

10. An aqueous glycol solution which has been concentrated by a process according to any of claims 1 to 9.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon) Ltd.—1982.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.